New treatment technology to remove worms in biological sand filter

Christensen, Sarah Christine Boesgaard; Larsen, Sille Lyster; Asmussen, Olaf; Boe-Hansen, Rasmus; Albrechtsen, Hans-Jørgen

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

The 10th Nordic

DRINKING WATER CONFERENCE

Reykjavík, September 28–30 2016

PROGRAM

NDWC NORDIC DRINKING WATER CONFERENCE

Abstract title: New treatment technology to remove worms in biological sand filter

Author(s): Sarah C.B. Christensen; Sille L. Larsen; Olaf Asmussen; Rasmus Boe-Hansen; Hans-Jørgen Albrechtsen

Country: Denmark

Organization(s): DTU Environment, Technical University of Denmark

Organization(s) type: University

Abstract text:

Introduction

Water treatment in biological rapid sand filter is a sustainable green technology which is extremely resource and energy efficient. Since all Danish drinking water is ground water based, the simple treatment consists of aeration and filtration without use of disinfectants. Microbiological processes remove e.g. ammonia, manganese and iron in the raw water, and it is therefore a prerequisite that the proper functional bacteria are present and under the right conditions. However biological sand filters have proven also to host higher organisms such as segmented worms (Oligochaeta). The largest worms found in Danish sand filters were 10 cm long. The large segmented worms are an aesthetic challenge to the water utilities as worms in tap water have been reported by consumers.

Danish utilities have previously used high concentrations of chlorine to remove worms from full scale filters. However this treatment killed the functional bacteria, and a utility reported that sand filters treated with sodium hypochlorite did not meet the required level of ammonia removal for half a year after treatment.

Aims

The main aim of this study was to:

- develop a technology to remove worms from biological sand filters while minimising the effects on the water treating abilities of the filter

Secondary aims were to:

- gather information from Danish utilities on occurrence and removal of worms in sand filters

- develop methods to collect worms in sand filters

- identify worms from Danish water works

Methods

The study was conducted during 2014 and 2015 and included field sampling, laboratory studies and analyses as well as field studies. Furthermore the study included data of worm occurrences at Danish utilities gathered since 2007

Results

Nine methods to collect worms from sand filters were developed and applied through sampling campaigns at Danish water works.

Worms from a Danish utility were identified by DNA analysis as ”Dendrodrilus rubidus”. Since Dendrodrilus rubidus is a terrestrial worm, survival studies with closely related terrestrial worms were conducted in drinking water with filter sand to investigate whether terrestrial worms are able to survive in water. As of today, the investigated compost worms Eisenia fetida and Eisenia veneta have thrived

in aerated water for 14 months.

Worms were registered at water works throughout Denmark and were hence not confined to a specific area. All infested water works had relatively high concentrations of methane in the raw water, which is a source of organic compounds if it is not completely stripped off but utilized by methane-oxidizing bacteria. High levels of organic compounds in sand filters support populations of higher organisms such as worms.

Four treatment technologies were tested on Eisenia fetida and Eisenia veneta in laboratory experiments; hydrogen peroxide (H2O2), nitrogen (N2), carbon dioxide (CO2) and monochloramine (NH2Cl).

CO2 treatment and chlorine treatment as reference (NaOCl) were also investigated in pilot filter columns at a water works since they were the only methods which eliminated the worms within two days.

All the worms in the filter columns were killed after six hours of NaOCl treatment, which was also the result of six hours of CO2 treatment. All worms survived in the control without treatment. Treatment with NaOCl impaired the functionality of the filter and no ammonium was removed from the water after treatment. CO2 treatment on the other hand did not reduce ammonium removal, and 100 % removal was measured immediately after the treatment was completed. Hence, CO2 treatment of worms in biological sand filters was an efficient method, which did not impede the functionality of the filter.

Acknowledgements

The study was supported by the Programme for Green Technology by the Danish EPA and two Danish utilities.